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AGRICULTURAL
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For All

We hear a lot about what agricultural research has meant to farmers. But what has it meant to other folks?

The fact is that agricultural research has played a vital part in making possible this country's urban industrial economy, with its high standard of living.

We have such an economy because technological advances in agriculture have released labor to produce other goods and services. In 1910, 1 farm worker produced food enough for only about 7 persons; in 1957, 1 worker produced enough for about 23 persons. It's research that has provided the basis for the development of our efficient system of producing food. feed. fiber, and forest products. And along with this has evolved an efficient marketing system to assemble, transport, process, store, and distribute these products.

In turn, great benefits from technological progress in industry have come to farm people. They have machinery and equipment to lighten their labor. They enjoy automobiles, electric power, and other essentials of modern living.

Thus, technological advance in agriculture and technological advance in industry are mutually interdependent. They have worked together to make possible our present high levels of living for farm and city people alike.

It's important to keep this system healthy, and the CORE report (AGR. RES., February 1960, pp. 2, 3–5) brings out a point that we would do well to keep in mind:

Less advanced societies maintain a relatively stable existence at a low level. but the United States has chosen the more risky path of progressively higher levels of consumption based on an intricately interrelated, highly organized system of production, processing, and marketing. Maintaining and developing this system requires constant attention as rapid adoption of technological advances, based on research, raises other questions for research to consider.

So agricultural research must keep aware of current needs—and even anticipate future difficulties. Research provides the surest means of finding practical. lasting answers.

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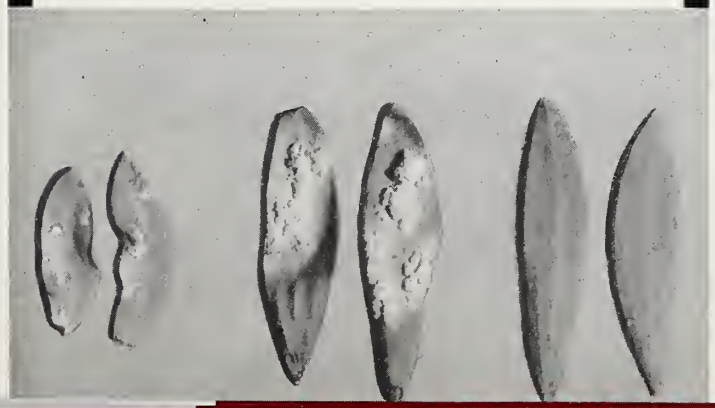
Dead spots on leaves (left, below) and on plant (left above) show physiological resistance of flax to rust fungus. Only inoculated leaves are affected; infection can't spread. Some plants show no reaction (leaves below, right) because death of fungus occurs so quickly. Susceptible plants (above, right) and leaves (center, below) show numerous infection centers in which fungus grows and reproduces, spreading disease.



BREAKTHROUGH ON PLANT DISEASE

A team of scientists has given us the important first step toward understanding plants' physiological resistance to disease—a condition that has long been a puzzle

■ Presence or absence in a plant of a protein identical to a protein in a disease organism may account for susceptibility or resistance of the plant to that disease organism.

A study by State and USDA scientists showed this was the case in flax plants susceptible or resistant to different races of the rust fungus *Melampsora lini.* Plants susceptible to a race contained a protein also found in that race; plants resistant to the race did not.

This discovery provides the first concrete evidence of the nature of physiological resistance. Bacteriologist J. A. Doubly of the North Dakota Agricultural Experiment Station, ARS plant pathologist H. H. Flor, and biochemist C. O. Clagett, now at Pennsylvania State University, made the study at Fargo.

BREAKTHROUGH ON PLANT DISEASE

(Continued)

In physiological or hypersensitive type resistance, the disease organism enters the plant but does little damage. Invaded plant cells and nearby cells die; so does the pathogen.

Unlike structural resistance to disease, which prevents the pathogen from entering or moving within a plant because of thick cuticle or cell walls, physiological resistance has not been understood. We don't know yet how it works, but the discovery by the three scientists gives the essential first step to learning how and why plants are resistant or susceptible to disease.

Susceptibility, protein linked

Serological tests demonstrated that the rust fungus and flax plants susceptible to it had a protein in common and that resistant plants lacked such a protein. The proteins concerned are of the globulin class. (Globulins are insoluble in water, soluble in neutral salts.)

Identification of proteins through serological methods is based on the same principles that apply to immunization of man and animals against some diseases. When certain disease organisms, proteins, and some other compounds are injected into a warm-blooded animal, antibodies to the injected substances form in the animal's blood serum. Antibodies (which are themselves proteins) render the injected substances innocuous by combining with them.

Antibody-antigen tests used

The antibodies react in the same way whenever the same substance is introduced into the blood. They are specific to the substance (antigen) that causes their formation—a smallpox immunization protects only against smallpox. This is because antibodies combine *only* with their specific antigens—fitting them perhaps as a custom-tailored suit fits only the person it was made for.

Because of this specificity, antiserum (blood serum containing antibodies) prepared against a known substance can be used to identify that substance in laboratory tests. In the precipitation test, for example, solutions of an antiserum and its specific antigen form a characteristic precipitate; if the antigen is not specific to the antiserum, little or no precipitate is formed.

Two types of serological tests were used in the detection of the proteins linked to rust susceptibility. Globulins from each of four lines of flax plants and four races of the rust were prepared and injected into rabbits as antigens, and antiserum for each was obtained. The four lines of flax differed from each other essentially only in a gene controlling reaction to the rust: the four races of rust differed from each other in ability to cause disease on the four lines of flax.

The globulins from each flax line and each rust race consisted of a number of different proteins. In each case, however, one protein was present in greater amounts than the others so that each flax line and each rust race was characterized by one *major* protein. These characteristic major proteins are identified here and in the accompanying diagram as a, b, c, and d for rust races A, B, C, and D, respectively.

Resistance studies continue

The tests showed that flax lines susceptible to particular rust races contained, in small amounts, proteins identical to the characteristic major protein of the rust races. For example, flax line 1, which is susceptible to all four rust races, contained proteins a, b, c, and d, in minor amounts. Flax line 3, susceptible to races C and D, contained proteins c and d in minor amounts but did not contain proteins a and b. In each case where a flax line was resistant to a rust race, it did not contain the protein which characterized that rust race. The susceptible flax lines contained a protein in common with their pathogens.

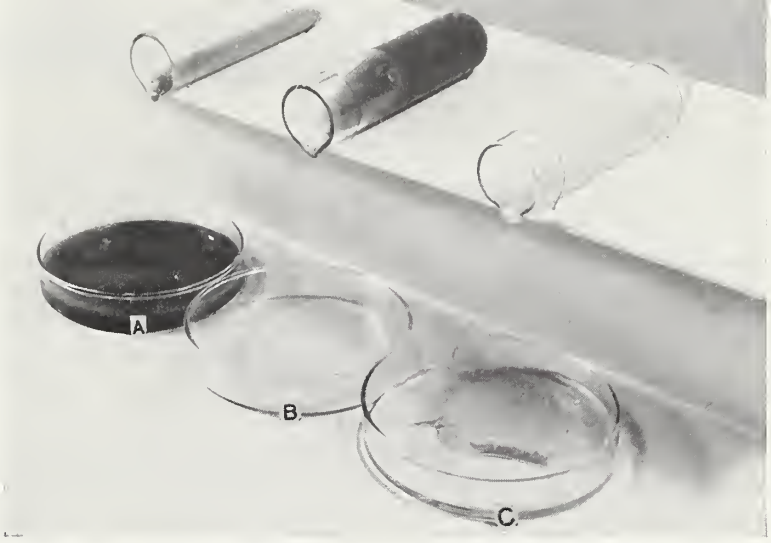
Doubly and Flor are continuing the study of resistance and susceptibility with other flaxes and rusts. ☆

RELATION of PROTEINS to RUST REACTION

FLAX LINES	RESISTANT TO RUST RACES	SUSCEPTIBLE TO RUST RACES	CONTAINED PROTEINS
1	—	A, B, C, D	a, b, c, d
2	A	B, C, D	b, c, d
3	A, B	C, D	c, d
4	A, B, C	D	d

1=Bison 2=Koto x Bison 7 3=Cass x Bison 7 4=Ottawa 770B x Bison 7
Rust race A=1 B=210 C=19 D=22

After whole juice (A) is washed, the remaining cell walls containing insoluble pectin and cellulose will not flow (B). Pure cellulose (C) is less viscous.



Key to Tomato Juice Consistency

Cell walls—one of smallest solid fractions—determine thickness

The full, rich body or consistency of tomato juice is almost entirely dependent on one of its smallest solids fractions—the tomato cell walls. They make up only about 3 percent of the solids in tomato juice, yet they largely determine how thick it is.

Processors of tomato juice, catsup, and other tomato products have long believed that pectin is all-important to consistency. For this reason, tomatoes for processing are usually preheated to 185° F. to inactivate the enzymes that would otherwise destroy the pectin. Research has shown that this step is valuable, but not entirely for the reason supposed.

Some years ago, a group of food researchers at the New York Agricultural Experiment Station, Geneva, including D. B. Hand, J. C. Moyer, J. R. Ransford, and the late J. C. Henings, prepared some thick tomato juices at the relatively low preheating temperature of 170° F. The thickness of these juices could not be explained by the pectin theory of consistency, for at 170° the enzymes in the juice were activated, and virtually no pectin was preserved.

USDA chemists R. T. Whittenberger and G. Nutting, of the Eastern utilization division, near Philadelphia, who participated in these experiments, studied the pectin-free thick juice under the microscope. The most prominent characteristic they noted was the existence of many well-defined cell walls. The ARS scientists set out to determine the contribution to consistency made by these cell walls, which are an essential part of the insoluble fraction.

Washing removes soluble solids, isolates walls

In an effort to isolate the cell walls of tomato juice, the researchers "washed" commercial samples through a fine sieve. Four or five such washings removed virtually all soluble solids and many small insoluble granules. There remained essentially a suspension of cell walls. Restored to original volume with distilled water, the product was actually thicker than the original whole juice, although it contained less than 6 percent of the solids originally present and only about 10 percent of the pectin. (About 90 percent of tomato pectin is soluble.) The walls appeared to have a water-binding effect that was enhanced by removal of the soluble solids. Homogenizing the suspension increases its viscosity further by breaking up the cell walls and exposing more of their surface.

Test results will help commercial processors

This work suggested that in the commercial processing of tomato juice, consistency is controlled not primarily by the amount of pectin solubilized but by the quantity and configuration of the cell walls retained.

Cell walls consist mainly of cellulose, permeated with some pectin. This is insoluble pectin. When the scientists removed this pectin enzymatically they noted a distinct loss in viscosity. The insoluble pectin probably contributed to consistency by increasing the water-binding capacity of the cell walls.

This work has provided a new interpretation of tomato-juice consistency. By showing the importance of tomato cell walls, it explained why relatively thick juice can be made in the absence of pectin. It revealed why and how consistency can be controlled in commercial processing by adjustment of the finishing and homogenizing machinery. And it demonstrated that preheating is valuable for the *insoluble* pectin it preserves.

These findings are of special value to makers of catsup and other concentrates, where more thickness is required than in tomato juice. ☆

What Makes Good HAY WAFERS

Proper curing is especially vital; crops also must be put in uniform windrows to enable successful processing

■ Careful drying of forage is the most important part of the recipe for making high-quality hay wafers. But certain handling procedures are almost equally important.

The methods of wafering several kinds of long forage in windrows were studied last fall by USDA agricultural engineers D. T. Black and J. R. McCalmont at the Agricultural Research Center, Beltsville, Md. They worked in cooperation with the Maryland Agricultural Experiment Station.

High humidity lowers quality

During periods of high humidity, the ARS researchers often had trouble making high-quality wafers. So they believe better wafers can be made in dry-weather areas. And while the studies answered many questions about wafering hay, more experiments are necessary. Here is what the researchers have learned so far:

CROPS—Those adapted to wafering with present experimental equipment include legumes and grass-legume mixtures containing at least 60 percent legumes. Second- and third-cutting alfalfa, red clover and timothy, alfalfa and orchardgrass, and sericea lespedeza were used successfully.

WINDROWS—These were best when formed of uniformly dry forage. Uneven windrows had excessively light sections that lacked the bulk needed to maintain the correct pressure necessary to form good wafers.

MOISTURE—Highest quality wafers were made of forage containing 10 to 14 percent moisture. But good wafers can be made of forage of much greater moisture content than 14 percent—if the moisture is evenly distributed. Wafer quality decreases when the moisture content varies greatly within a windrow, because the most desirable pressure cannot be maintained. When the moisture content is higher than 14 percent, wafering pressure must be reduced to prevent mashing and crumbling.

STORAGE—Wafers of up to 14 percent moisture content were stored safely at depths less than 7 feet. However, more study is needed to determine drying requirements for high-moisture wafers. And the agricultural engineers wish to determine which temperatures, humidities, and storage conditions cause heating and mold formation in stored wafers.

EQUIPMENT—Portable wafering machines being developed by commercial firms produce up to 4 tons of wafers per hour. These wafers are square, circular, or rectangular, and of various thicknesses. This machinery, still experimental, can be adjusted to operate at proper speeds for making wafers from various size windrows, if they are uniform.

Less space and labor required

Greater use of wafers seems desirable, since hay is a large and bulky farm crop. More than 100 million tons, about 84 percent of production, are fed on farms. Harvesting, storing, and feeding hay add up to a lot of backaches, even though much is self-fed and partially mechanized handling systems are used.

Wafering is being studied as a means of reducing bulk so hay can be handled mechanically with minimum hand labor. And wafering is considered a more desirable method of field-processing chopped or long forage for dairy cattle than pelleting hay after it is finely ground. ☆

Compression of unwieldy hay into small wafers like these is one promising way to reduce bulk of the crop. Wafers will allow machinery to do away with much hand labor now necessary when handling the forage during harvesting, storing, and feeding. Dairy cow, one of several in current ARS feeding trial, demonstrates palatability of the wafers.

HOUSING AFFECTS BROILER GROWTH

Location effects may give false picture of genetic differences between broiler stocks during critical evaluation tests

■ Do living quarters affect the growth rate and feed conversion rate of broilers? Yes, to *some* extent, according to USDA. Enough so that it's a factor that shouldn't be overlooked in any critical test for the evaluation of broiler stock performance. But not enough to invite a near nervous breakdown for hundreds of broilers by intermingling them. Sex and source of stock play a more important role in determining differences in growth and feed conversion rate.

This information helps fill in the picture for supervisors of random sample tests and poultry breeding researchers, who have wondered if stock raised in one pen would perform differently in another.

Critical evaluation of broiler performance requires housing that permits detection of genetic differences between stocks, without introducing additional differences (the scientists call them location effects). What are some of these possible differences? Whether or not houses face the sun, the kind of care the birds get, size and shape of houses, the type of flooring, and many other similar factors can add up to give a false picture of genetic differences in birds.

If these location or pen effects *did* exist in certain facilities, researchers and supervisors reasoned, it would then be necessary to repeat test samplings. However, if location effects *didn't* exist, it would then be possible in each test to use single pens and evaluate more stock at one time without worrying about the accuracy of the test due to variations in housing.

Growth rate and feed conversion measured

ARS poultry geneticist C. W. Hess with poultry specialist E. F. Dembnicki and biometrician J. L. Carmon of the Georgia Agricultural Experiment Station at Athens ran tests to measure any differences in growth rate and feed conversion due to location, and to evaluate separate and intermingled rearing of broiler stock. The study was conducted as part of the Southern Regional Poultry Breeding Project, involving agricultural experiment stations in the South and ARS.

Each of 10 commercial broiler stock breeders provided enough eggs to supply 800 chicks—a total of 8,000. Chicks from each source were divided into 4 groups of 100 males and 100 females each. Three of these groups were reared separately, while the fourth group was further subdivided into 10 units of 10 males and 10 females each and reared intermingled with a similar number of chickens from each of the other 9 sources. Two identical houses of 20 pens each were used. Feed, water space, and equipment were kept identical in all pens.

Bulk body weights by sex and source were taken at 8 weeks of age and individual body weights at 9 weeks. Feed consumption was recorded at 8 and 9 weeks of age. Mortality records were kept for all groups.

At 8 weeks, intermingled birds weighed slightly more than those reared separately. But at 9 weeks, the advantage was slightly in favor of birds reared separately. The weight disadvantage for the mixed group may have been due to social tension, which becomes noticeable through bossiness and pecking in males at about 8 weeks of age. Tensions would normally be greater when birds from several sources are reared together.

Birds from same source perform differently

When body weight data for separately reared broilers were analyzed, substantial differences for source and sex showed up, but no real difference could be traced to location. At 9 weeks, meaningful differences in body weight could be traced to interaction of location and source, and highly meaningful differences were traced to the interaction of location, source, and sex. This indicates that broilers from the same sources will perform differently in some locations than in others. Even birds of the same sex from the same sources will perform differently in different locations.

Differences were found in feed conversion due to source of the broilers, none due to location. And this was true even though all the stock tested was from commercial broiler stock breeders and didn't differ as much in growth rate as would be expected if noncommercial or dual-purpose stock had been included.

The scientists concluded that under their conditions, location or pen effects aren't important if chicks from a given source are reared separately and if housing conditions are uniform. But location effects must be considered when birds are intermingled.

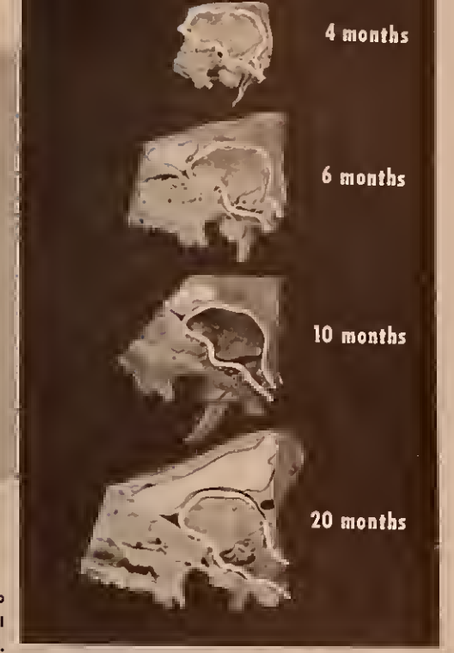
Thus, separate rearing is advantageous from the standpoint of eliminating location effects; it's also preferable where feed conversion data is needed. Such data can't be obtained with intermingled rearing. ☆

Captive bolt penetrates back of cattle skull and enters brain cavity as shown. Doris Sperring and R. L. Hiner demonstrate angle of entry.

Animals may be immobilized before slaughter with captive bolt type instruments. Five at left are driven by a powder charge; the one at right, with compressed air.

Penetrating captive bolt well placed in pig skull at left, and misdirected in one at right. Animals were 6 months old and weighed 200 pounds when slaughtered.

Lateral view, some skulls, shows effective blow entered brain, rendering animal unconscious. Misdirected blow at right entered eye area; animal was semiconscious.



Skull thickens and sinus cavity moves back to occupy entire space above brain as pigs get older. White area, sinus cavity; brain, outlined.

A REPORT ON HUMANE SLAUGHTER

Tests show practical methods of rendering animals unconscious, giving painless death

■ Humane slaughter procedures must be in effect after June 30 of this year in all meatpacking plants selling products to Federal agencies.

To many packers, this will mean a continuation of practices already established. To others, it will mean the planning, installation, and integration of slaughtering practices that have been designated humane by Federal law and regulations. Although many packers face some adjustment problems, those of the smaller operators are particularly acute. They generally have neither the resources nor the facilities for research.

Knowing this, USDA studied humane slaughter of hogs with emphasis on problems of the small packers.

In work underway at the ARS Agricultural Research Center, Beltsville, Md., scientists are studying the most practical methods of "immobilizing" or rendering animals unconscious so they will feel no pain when killed seconds later. Studies are concentrated on effective use of electrical and mechanical stunning instruments, which appear best suited for small packers.

The mechanical-stunning studies are mostly on hogs because their skull structure makes the problem of immobilizing them difficult. Cattle and sheep—unlike hogs—have fairly uniform, relatively thin skulls. This plus important physiological differences, makes cattle and sheep easier to stun.

Changes in bone structure with maturity have an important bearing on the placement of the blow and the power load of the instrument. As a first step in learning more about the bone structure of the head in relation to placement of the stunning instrument, skulls of hogs from 3 to 22 months of age were examined. A set of measurements was adopted to evaluate differences.

Measurements from the frontal sinuses to the occipital area (separating the sinus cavity from the skull behind) showed that the sinuses extend further up to the occipital area with age. Thus, although skull thickness increases with age, there is less *solid* frontal bone since the sinus area moves up with age, too.

Force of stunning blow varies with age of animal

Obviously, a blow delivered with the same force with the same instrument will *not* have the same effect on all animals. A young animal may be quickly and quietly immobilized by a well-placed blow that injures the brain. A similar blow in an older animal may crush the skull. But the blow may enter the sinus cavity without producing unconsciousness.

Livestock specialists R. L. Hiner and Doris Sperring are trying to establish a numerical scale relating age and weight with skull development. This should give a clearer picture of where the stunning blow should be placed and how much impact is needed.

What immobilization methods can meatpackers use? The Federal Government has designated four as humane—chemical, electrical, mechanical, and gunshot.

Carbon dioxide—the only chemical so far approved—induces deep anesthesia when properly administered. Equipment for carbon dioxide use is rather costly to install. But the method is being effectively used (mostly on hogs) by some of the large packers.

Recently developed electrical methods look promising and are being installed by some packers. Electrical stunning equipment requires skill and accuracy but is relatively inexpensive to install and operate.

The two types of mechanical stunning instruments—concussion and penetration—are driven with compressed air or by a powder charge. The concussion type generally has a mushroom-shaped head; a well-placed blow renders the animal unconscious. The penetration or "captive bolt" type enters the skull like a bullet and retracts, leaving the animal unconscious.

The choice of methods and instruments depends upon a combination of many factors. What's best and most economical in one plant may not be in another. As other methods are shown to be humane, they may also be approved by the Federal Government.

Mere installation of equipment to meet requirements doesn't guarantee humane slaughter. Packers have other major problems to solve before these procedures can function as they're supposed to. Here are a few:

Better methods must be developed to deliver practical numbers of *calm* animals to the immobilizing area. Ways must be found to completely and safely restrain the animals during immobilization. Workers must be trained to use equipment correctly. And all restraining and immobilizing equipment must function properly and be adapted to the location in the packing plant.

Studies deal with better handling techniques

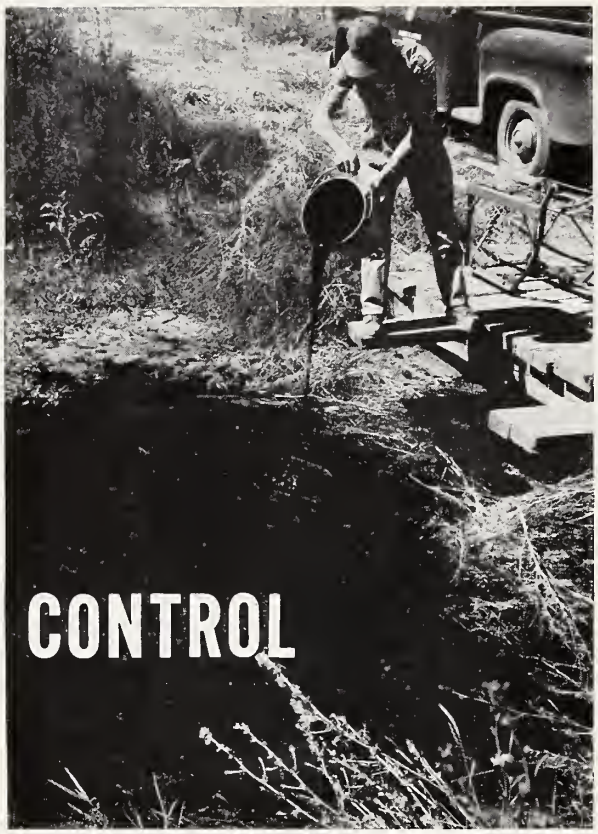
Meatpackers are doing much of this work on their own. But USDA research is helping, too. Here, the scientists are working on ways to deliver calmer animals to the immobilizing area. Work is also progressing on the development of inexpensive and efficient chutes that would be especially useful for small packers.

Considerable basic research is needed on other methods of immobilization and dispatching, measuring tissue changes, depth of anesthetization, and measuring pain.

Needed, too, are studies on possible effects of various immobilization techniques on post-mortem changes that affect keeping quality of meat. Some of the answers are sought in ARS contract work at Cornell University and the University of Minnesota. ☆

One treatment of test chemicals controlled plant pests in canals for 2 to 9 miles

BETTER WATER-WEED CONTROL



Dye, poured into irrigation canal before and after chemical application, indicates distance traveled by aquatic herbicide.

■ Acrolein and quaternary ammonium compounds show promise for controlling aquatic weeds in western irrigation and drainage canals.

Single treatments of acrolein last summer gave satisfactory control of aquatic weeds in canals for 2 to 9 miles. Quaternary ammonium compounds provided satisfactory control for up to 2 miles. Evaluations of the chemicals were made by USDA scientists, in cooperation with the U.S. Bureau of Reclamation. Experiments were conducted in Arizona, Montana, Washington, and Wyoming.

Some common aquatic plant pests controlled to a varying degree by the chemicals in the tests were algae, chara, and several pondweeds, including sago, gigantic sago, leafy, American, horned, and Richardson's.

Aquatic weeds clog irrigation and drainage canals in most Western States, preventing normal flow of water. If uncontrolled, these weeds may cause irrigation canals to overflow and keep water from reaching crops. In drainage canals, the water level may be raised too high for effective drainage of land. This, plus removing the weeds mechanically, costs thousands of dollars annually.

A commercial formulation of acrolein already is available for use as an aquatic herbicide. ARS researchers point out, however, that many things must be learned before quaternary ammonium compounds can be recommended for control.

For example, concentrations of the chemicals that will not damage crops and costs are being determined. More must be learned about their effectiveness as herbicides at maximum distances from the point of application, what effect the salt and silt content, temperature, velocity of water, and other conditions have on weedkilling action. Relative effectiveness, compared with xylene-type aromatic solvents—now used extensively—also must be determined.

Possible toxicity to beneficial soil bacteria, livestock, and other land animals must be studied. The compounds appear toxic to marine life and fish, as have most other chemicals tested for aquatic weed control. But this toxicity is not a primary concern in irrigation and drainage canals, because the object is to make water available to crops. ☆

Herbicide-water mixture is pumped through hose into stream in wake of dye, as rate of application is measured at pump. Chemicals gave satisfactory control of algae, chara, and several pondweeds last summer in Arizona, Montana, Washington, and Wyoming. Quaternary ammonium compounds and acrolein were tested.

HIGHER CRIMSON CLOVER SEED YIELDS

■ Hairy vetch in crimson clover grown for seed can be successfully controlled with the application of a properly timed annual spray of MCPA herbicide.

USDA scientist W. O. Lee at Corvallis, Oreg., obtained 90 to 100 percent control by spraying one-fourth pound of MCPA (2-methyl-4-chlorophenoxyacetic acid) in 40 gallons of water per acre. Yields were not reduced when the MCPA was applied during the first 2 weeks of March. The vetch was growing rapidly and shoots were 10 to 12 inches long. Crimson clover was in the rosette stage, 5 to 6 inches in diameter. This stage of growth might occur at other dates in various areas, and the time of treatment would vary, depending on stage of growth of the vetch and crimson clover.

Lee reported similar results in 1958 and 1959 in ARS studies, conducted with cooperation of the Oregon Agricultural Experiment Station.

Hairy vetch, a good legume, is considered a damaging broadleaf weed when found in crimson clover grown for seed. Both plants germinate at the same time, but vetch grows more rapidly, forming a canopy that covers the clover, causing it to lodge, reducing harvestable seed yields. When the clover is ready for harvest, the vetch is still green, causing threshing difficulties because of tangling and high moisture content.

Lee found that a spray of MCPA in January or February provided only temporary vetch control. A late-March or early-April spray provided good vetch control, but the clover was severely injured and little seed set. Even though the early-March treatment injured the clover, it recovered and produced a normal seed crop.

Ground equipment was used in the studies, although aerial sprays are common in the Oregon area. Farmers treating from the ground could probably obtain equally good results by using 20 gallons or less instead of 40 gallons of water per acre. However, the rate of one-fourth pound of MCPA per acre remains constant.

Lee says it would probably be less expensive and more effective to treat whole fields rather than spot infestations, because the plants grow rapidly. When the vetch gets about 1 foot high, it quickly spreads laterally and finally grows up to 2 feet high.

MCPA also controls wild mustard, wild radish, and other annual winter weeds, but it does not kill grass weeds and volunteer small grains that frequently infest crimson clover in Oregon. ☆

NEW BEAN INDUSTRIES FOR NORTHWEST?

■ New beans that are resistant to curly top and other viruses—along with a control for fusarium root rot—may soon open the way to new seed growing and bean processing industries in the Columbia Basin.

D. W. Burke, USDA plant pathologist at Prosser, Wash., is improving high-quality garden and dry bean selections that are resistant to virus diseases. He is also obtaining some control of fusarium root rot, a major fungus disease of beans, with nonpathogenic fungi grown on barley straw or alfalfa hay to form composts. These are applied to the soil at planting time.

The basin's climate and soil favor top bean yields, and nearly rain-free summers prevent development of seed-borne bacterial diseases, and leaf- and pod-spotting fungi. But viruses, mainly curly top, hinder production of garden and some dry beans. If crop rotation is not practiced, fusarium root rot can infect new plantings and reduce yields ⅓ to ½ in a few years.

The Washington Agricultural Experiment Stations are cooperating with Burke in conducting this research. ARS scientists at Twin Falls, Idaho, and Beltsville, Md., are aiding in the work, which began several years ago.

The most promising disease-resistant garden beans under development yield well, mature early, and have dark, tender, succulent pods desired by industry for canning and freezing. These selections are suited to mechanical harvesting, since the pods are evenly distributed on the plants and do not touch the ground.

The new dry bean types mature early, yield well, and have good seed color, size, and shape. General information on the selections will not be available until they can be introduced as varieties, because some may be discarded after additional tests.

Currently, Burke is seeking a practical way of applying the composts. He got favorable results last summer by applying them as dusts in the seed furrow at 50 pounds per acre. The nonpathogenic fungi may produce antibiotics, compete for nutrients, or attack and kill the fusarium fungus. More research is needed before this method is recommended for use by growers. ☆

Dense growth of alfalfa on treated slick spots indicates average yields are possible through use of gypsum, deep plowing, subsoiling.

GYPSUM helps eliminate Alkali Spots

■ Promising uses of gypsum, deep plowing, and subsoiling to improve unproductive "slick spots" on irrigated land in southwestern Idaho and adjacent areas have been demonstrated by a USDA soil scientist.

Slick spots are small areas of alkali soil that are now or have been unusually high in sodium salts. Near the surface there is a high-sodium layer that effectively seals the soil. This prevents water from entering and moving freely, seriously limiting plant growth. Underlayers of hardpan restrict root growth. Farming costs are increased, land values decreased, and crop yields reduced.

Treatments include mixing gypsum in affected soil at the rate of 20 tons per acre, in combination with plowing 24 to 30 inches deep or subsoiling to break up hardpan. Deep plowing also mixes the soil, bringing up lime and some gypsum that may be naturally present. This may reduce the amount of gypsum necessary to cure the spots. (Gypsum is a high-calcium material that displaces the sodium, coagulates the soil, and helps increase moisture movement for leaching away excess sodium.)

Test crops were not stunted

Normal yields of barley and alfalfa-grass forage were obtained from test plantings grown on treated slick spots in 1958–59. Soil condition and water intake rates were greatly improved. In addition, sodium and salt concentrations were reduced significantly by the end of the first crop year.

These experiments conducted near Caldwell, Idaho, by ARS soil scientist W. W. Rasmussen, stationed at Ontario, Oreg., represent an outstanding advance in developing a practical cure for slick spots. Research is continuing in cooperation with the U.S. Bureau of Reclamation, Soil Conservation Service, and Idaho Agricultural Experiment Station.

Cost studies are planned

Gypsum will probably cost $100 to $200 per acre of slick spot treated, according to Rasmussen. Deep plowing can be done for $25 to $30 per acre and subsoiling for about $15 per acre. The total cost for treating land affected up to 30 percent by slick spots should not exceed $75 to $85 per acre. Total costs will be determined next summer, and attempts will be made to develop less expensive treating methods. Effect of the treatments on surrounding unaffected soil is also being studied.

Slick spots are found throughout about 250,000 acres of irrigated and potentially irrigated land in the lower Snake River Valley of southwestern Idaho and southeastern Oregon. About 10 percent of the area is affected, and some land may be as much as 40 percent slick spots. ☆

SOIL NUTRIENTS AND PLANT COMPOSITION

■ If a growing plant is short of one of certain essential mineral nutrients, it may not metabolize some amino acids or form the same amount of protein as plants supplied with all essential nutrients. But the proteins have the same amino-acid composition as that of normal plants of the same variety.

This was shown in studies at the USDA Plant, Soil and Nutrition Laboratory at Ithaca, N.Y., where researchers J. F. Thompson, C. J. Morris, and Rose K. Gering grew turnip plants in solutions containing all—or all but one—of the essential nutrients. Nutrients tested were nitrogen, phosphorus, sulfur, potassium, calcium, and magnesium. Plants short in any one nutrient were stunted and showed deficiency symptoms.

The combination of amino acids in certain characteristic proportions to form a plant's proteins is apparently regulated by inherited factors. The amount of uncombined amino acids in turnip plants in this study varied according to the nutrient deficiency. However, this variation has little effect on the plant's nutritional value to man and animals since the bulk of the plant's amino acids are combined in the protein.

The amino acid glutamine was high when amino-acid content was high, suggesting that glutamine may be related to the plant's protein metabolism.

When plants were grown without nitrogen, their leaves contained less of the uncombined amino acids threonine, proline, cysteine, and lysine than normal leaves. Roots from deficient plants, however, had about the same content of amino acids as normal plants.

Phosphorus-deficient leaves and roots contained more of the uncombined amino acids than normal tissues, and differences in the glutamine, proline, isoleucine, and arginine amino acids were greater than could be accounted for by the differences in the nonprotein nitrogen. Possibly these amino acids require phosphorus for metabolism. And, the combination of amino acids into protein was reduced by a low phosphorus level.

Many uncombined amino acids were higher in sulfur-deficient tissues than in normal ones, but the sulfur-containing acids (cysteine, methionine, and methylcysteine-sulfoxide) were lower.

Individual nutrients have different effects

With potassium, calcium, and magnesium deficiencies, the leaves had a much higher nonprotein-nitrogen content than normal leaves, whereas the roots showed little difference. This may have been because the deficiency was more severe in the leaf or because the roots responded differently to the deficiency. Values for several uncombined amino acids in potassium- and calcium-deficient plants were higher than normal, but magnesium-deficient plants had lower values.

These findings from the Ithaca tests show that individual nutrients differ in their effects on the various metabolic processes involving amino acids. ☆

DAMAGED COTTONSEED—WEAK ROOTS

■ Deterioration of the embryo root within cottonseeds is probably the principal cause of nubroot—abnormally short or missing taproots in mature cotton plants, USDA-State research shows. The condition may also be caused by strangulation of roots by soil compaction or hardpan, or damage to seedlings by soil fungi.

But ARS plant pathologists A. B. Wiles and J. T. Presley, in cooperation with the Mississippi Agricultural Experiment Station, found that nubroot occurred in test plants grown from deteriorated cottonseed even when neither soil conditions nor fungi was a contributing factor.

Cotton plants with nubroot are weaker and set fewer bolls than normal plants, tend to wilt readily, and may topple over during periods of moisture stress. Nubroot may lower yields by as much as 25 percent.

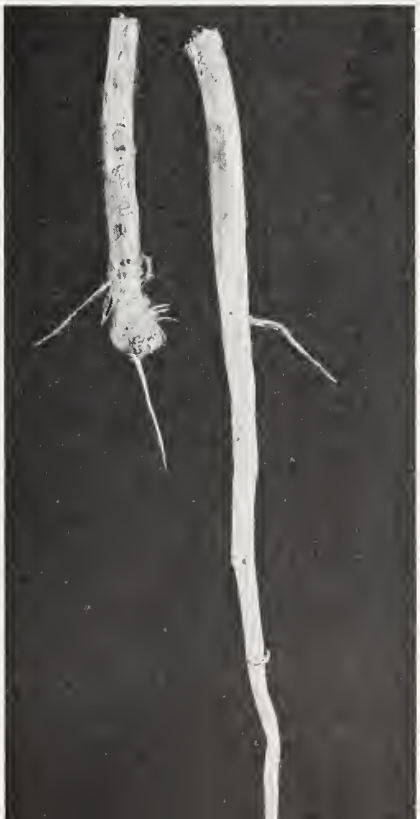
Wiles and Presley traced nubroot to seed deterioration after noting that many seedlings grown from deteriorated seeds had injured radicles (primary roots). Presley had previously shown that high temperature and humidity during storage damage the embryo plant within cottonseeds and that seedlings grown from such seeds are less vigorous than normal (AGR. RES., June 1959, p. 5).

Growth tested in sterile soil

The scientists selected 100 seedlings with damaged radicles and grew them in sterilized soil along with 20 normal seedlings. Examination of half of the plants 6 weeks later and the other half 3 months later showed that all the seedlings with damaged radicles grew into plants with varying degrees of nubroot. Normal seedlings with undamaged radicles grew into plants with normal taproots.

These results show the importance of adequate tests to determine the degree of deterioration of seed prior to planting time as a means of improving stands in cotton. ☆

Abnormally short root at left shows nubroot condition of cotton is aptly named. Taproot of normal length is at right. Both are from mature plants.



How to Hold a ROADBANK

Increased road construction is focusing more attention on importance of roadbank cover

■ Combinations of plants and mulches reduced roadside erosion in USDA research in the Southeast. Accelerated road construction has increased the importance of controlling this type of erosion.

Continuing research by ARS agricultural engineer E. G. Diseker and soil scientist E. C. Richardson at Cartersville, Ga., in cooperation with other agencies, points to reductions in roadside erosion that causes soil losses of up to 100 tons per acre a year.

Crown vetch appears to be one of the more promising cover plants being tested, but it needs temporary protection during a relatively long establishment period. Abruzzi rye is planted with the vetch to provide this quick cover. The vetch is green much of the year and does not need mowing. Grasses such as Bermuda and fescue also give good control, but they are a greater fire hazard in winter and may need extra fertilization after growth starts.

Fertilizing and liming roadbank soils are the first steps in establishing protective crops. Extra nitrogen must be added later.

While mulching is needed to establish crops on steep slopes, it is somewhat less necessary on slopes of 2 to 1 or less. Pine needle or straw mulch at the rate of 1 to 2 tons per acre gave improved stands and reduced erosion during the establishment period.

Jute thatching, a coarse, open-mesh, weblike material woven of heavy jute twine, has been valuable for protecting road ditches and waterways until a cover of vegetation is established. ☆

Crown vetch, promising in tests as a plant that can reduce roadside erosion, spreads by means of underground stolons. E. C. Richardson points to stolons, also shown in closeup. Abruzzi rye is sown with vetch for temporary protection.

Erosion-measuring device, installed near Cartersville, Ga., determines amounts of soil and water moving off bank in background. Photo at right shows device without cover.

Runoff water and eroding soil, after collecting in ditch, enter device and move through measuring weir at left, fall onto revolving wheel where the flow is sampled.

Pigment is "phytochrome"

"Phytochrome" is the name given to the light-sensitive pigment recently found by ARS scientists to be the triggering mechanism for plant growth. This pigment, through its sensitivity to red and far-red light, controls growth from seed germination through flowering and fruiting.

Isolation and further study of this pigment will increase basic understanding of the physiology of plant growth and development. (See AGR. RES., May–June 1953, p. 3; July 1953, p. 14; June 1954, p. 8; July 1955, p. 12; May 1956, p. 16; December 1956, p. 10; November 1959, p. 3.)

Unique sugar beet test

An unusual method for testing the resistance of sugar beet selections to curly top virus has aided greatly in producing resistant varieties.

Developed and used by USDA plant pathologist A. M. Murphy, the method essentially consists of planting breeding strains next to already diseased and susceptible beets in a large test field. This is done just before

beet leafhoppers, which spread the virus, invade the field.

It is known that some of the migrating leafhoppers carry the virus, but the diseased beets provide a positive source of virus. The susceptible beets not only offer a second source of virus but also prove the disease is spreading. A variety of intermediate resistance is also planted. It persists and supplies another source of virus after any susceptible variety is almost wiped out.

Sugar beet selections are evaluated by the ARS scientist near Twin Falls, Idaho, in an area surrounded by desert to keep the virus out of commercial sugar beet fields. Certain weeds growing in the desert serve as very effective host plants for great numbers of leafhoppers.

Working in cooperation with the Sugar Beet Development Foundation, Murphy aided in breeding such curly top-resistant varieties as U.S. 22, U.S. 35, and U.S. 41. Currently, monogerm sugar beet selections are being tested for resistance.

Curly top was the most devastating disease of sugar beets grown in the Far West. For example, in the 1930's crops failed, sugar factories were abandoned, and losses amounted to millions of dollars.

New Great Northern bean

Commercial growers should have no difficulty obtaining seed of Great Northern 1140, a new, early-maturing, high-yielding, disease-resistant, dry bean, suitable to areas where Great Northern-type beans are grown.

The variety is resistant to common bean mosaic and the "New York 15" strain of the disease. Developed by USDA and the Montana and Idaho Agricultural Experiment Stations, the variety also shows resistance to several strains of bean rust.

Because of its early maturity, Great Northern 1140 can be used to replant damaged crops. A second planting before mid-June will mature early enough to escape fall frost in most bean-growing areas. One less irrigation may be required.

Its growth habit may reduce white mold disease, which becomes more severe as soil surface moisture increases. The plant allows more air circulation near the base than other varieties, thus reducing moisture on or near the soil surface.

This variety, developed by W. J. Zaumeyer and H. R. Thomas of ARS, and M. M. Afansiev of Montana, is *not* curly-top resistant and should *not* be grown in the Columbia Basin or in Idaho near deserts where this disease is frequently serious.

Names of seed dealers having seed available can be obtained from the Idaho Crop Improvement Association. No seed is available from USDA or the Idaho and Montana stations.

DHIA cows returned $78

An average net profit of $78 per head was returned by cows enrolled in the National Cooperative Dairy Herd Improvement Association in 1958. But the average U.S. dairy cow returned only $28.

The $50 difference per cow demonstrates that management, based on any of three recordkeeping systems offered by the association, can lead to more profitable dairying. The recordkeeping systems enable herd owners to: (1) cull low-producing cows, (2) feed cows according to production, and (3) select the best stock for breeding herd replacements.

Recently compiled figures show that 2,232,268 cows—11.3 percent of

the U.S. total—from 66,089 herds were enrolled in DHIA on January 1, 1959. Included were 1,607,538 cows in Standard Record Keeping (a 3.6-percent increase over 1957), 549,916

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in Owner-Sampler (a 10.9-percent increase), and 74,814 in Weigh-a-Day-a-Month (a 6.2-percent decrease). Because Weigh-a-Day-a-Month was designed to introduce dairymen to record keeping, the decrease simply indicates a shift to another record system.

Records also indicate that DHIA members are accelerating the rate of herd improvement. For example, DHIA cows increased average annual production from 8,675 pounds of milk in 1948 to a record 10,068 pounds in 1958—an average yearly gain of 140 pounds. All U.S. dairy cows increased average production from 5,010 pounds in 1948 to 6,330 pounds in 1958, an average annual increase of 132 pounds.

Runoff carries fallout

Much radioactive strontium 90 from atomic fallout could lodge on soil particles that gather where sediments in runoff water accumulate, reports USDA soil scientist R. G. Menzel.

Of all fallout carried to soil, mainly by rainfall, about 1 percent was transported by runoff water in experiments at Tifton, Ga., and La Crosse, Wis. Although only a little strontium 90 was removed from the surface of the test plots, the element's concentration might be about 10 times greater at the base of slopes than on uphill plots, Menzel says.

Indications are that more than 1 percent of the fallout could be transported off steep slopes through use of cultivation practices that encourage erosion. But, in most agricultural areas, the fallout content of surface soil will not be greatly reduced by erosion.

The Georgia and Wisconsin Agricultural Experiment Stations cooperated with ARS in the studies.

Evaporation losses high

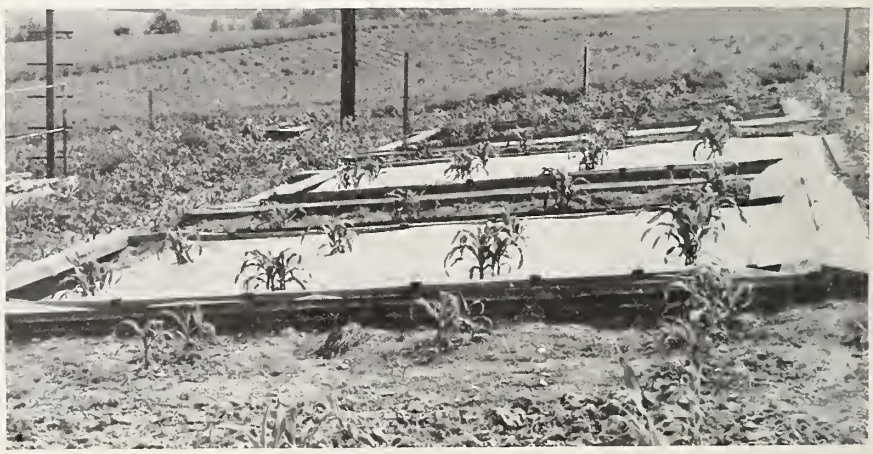
Evaporation caused over half the water loss from corn plots during an entire growing season in recent tests conducted by USDA scientists at the Soil and Water Conservation Research Station, Coshocton, Ohio. Only 44 percent of the loss came from the "breathing" of the plants.

Because of these large losses and the increased national demand for more water, research will be intensified to see if loss from the soil can be controlled.

The research was done by covering the surface of some of the test plots with clear polyethylene plastic when the corn was about 10 inches high. Two normal plots produced at the rate of 149 and 169 bushels to the acre. Test plot "A," which was covered with plastic, produced at the rate of 125 bushels. And plot "B," which was also covered but had water added underneath the plastic equal to the amount of rain during the period, produced 182 bushels.

"A" produced less than normal because it in effect had a continuous drought from June 6 to September 9 while the plastic was in place. "B" produced more because the normal amount of rainfall was added but no evaporation took place from the soil.

The research was done on lysimeters—small field plots encased in 8-foot-deep concrete walls with perforated steel-plate bottoms (see AGR. RES., April 1957, p. 6).



Plastic covers keep rain off one plot, prevent evaporation of water added to other plot. Setup helped scientists determine evaporation caused over half the water loss from uncovered plots.

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